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IV. *An Account of several extraordinary Meteors or Lights in the Sky.* By Dr. Edmund Halley, Savilian Professor of Geometry at Oxon, and Secretary to the Royal-Society.

THE *Theory* of the Air seemeth, at present, to be perfectly well understood, and the differing Densities thereof at all Altitudes, both by Reason and Experiment are sufficiently defined ; for supposing the same Air to occupy Spaces reciprocally proportional to the Quantity of the superior or incumbent Air, I have elsewhere proved that at 40 Miles high the Air is rarer than at the Surface of the Earth about 3000 times ; and that the utmost Height of the Atmosphere, which reflects Light in the *Crepusculum*, is not fully 45 Miles. Notwithstanding which, 'tis still manifest that some sort of Vapours, and those in no small Quantity, arise nearly to that Height. An Instance of this may be given in the great Light the Society had an account of (*vid. Transact.* Sept. 1676) from Dr. Wallis, which was seen in very distant Counties almost over all the South Part of *England*. Of which though the Doctor could not get so particular a Relation, as was requisite to determine the Height thereof, yet from the distant Places it was seen in, it could not but be very many Miles high.

So likewise that Meteor which was seen in 1708. on the 31st of *July*, between Nine and Ten a Clock at Night, was evidently between 40 and 50 Miles perpendicularly high, and as near as I can gather, over *Shereness* and the *Buoy on the Nore*. For it was seen at *London* moving horizontally from *E. by N.* to *E. by S.* at least 50 Degrees high, and at *Redgrave* in *Suffolk*, on the *Tarmonth* Road, about 20 Miles from the East Coast of *England*, and at least 40 Miles to the Eastward of *London*, it appeared a little to the Westwards of the South, suppose *S. by W.* and was seen about 30 Degrees high, sliding obliquely downwards. I was shown in both Places the Situation thereof, which was as described, but could wish some Person skill'd in Astronomical Matters had seen it,

that we might pronounce concerning its Height with more certainty : Yet, as it is, we may securely conclude, that it was not many Miles more Westerly than *Redgrave*, which, as I said before, is above 40 Miles more Easterly than *London*. Suppose it therefore, where perpendicular, to have been 35 Miles East from *London*, and by the Altitude it appear'd at in *London*, viz. 50 Degrees, its Tangent will be 42 Miles, for the Height of the Meteor above the Surface of the Earth; which alſo is rather of the leaſt, becauſe the Altitude of the Place ſhewn me, is rather more than leſs than 50 Degrees : and the like may be concluded from the Altitude it appear'd in at *Redgrave*, near 70 Miles diſtant. Though at this great Diſtance, it appear'd to move with an incredible Velocity, darting, in a very few Seconds of Time, for about 12 Degrees of a great Circle from North to South, being very bright at its firſt Appearance ; and it died away at the End of its Courſe, leaving for ſome time a pale Whitenefs in the Place, with ſome Remains of it in the Track where it had gone ; but no hisſing Sound as it paſt, or Bounce of an Exploſion were heard.

It may deſerve the Honourable Society's Thoughts, how ſo great a Quantity of Vapour ſhould be raiſed to the very Top of the Atmosphere, and there collected, ſo as upon its Accenſion or otherwiſe Illumination, to give a Light to a Circle of above 100 Miles Diameter, not much inferior to the Light of the Moon ; ſo as one might ſee to take a Pin from the Ground in the otherwiſe dark Night. 'Tis hard to conceive what ſort of Exhalations ſhould riſe from the Earth, either by the Action of the Sun or ſubterranean Heat, ſo as to ſurmount the extream Cold and Rareneſs of the Air in thoſe upper Regions : But the Fact is indiſputable, and therefore requires a Solution.

Like to this, but much more conſiderable, was that famous Meteor which was ſeen to paſs over *Italy* on the 21^{ſt} of *March* O. S. Anno 1676. about an Hour and Three Quarters after Sun ſet, which happen'd to be obſerved and well conſider'd by the famous Profeſſor of Mathematicks in *Bononia*

Geminian Montanari, as may be seen in his *Italian Treatise* about it, soon after published at *Bononia*. He observes that at *Bononia*, its greatest Altitude in the S. S. E. was 38 Degrees, and at *Siena* 58 to the N. N. W: that its Course by the Concurrence of all the Observers was from E. N. E to W. S. W. that it came over the *Adriatick Sea* as from *Dalmatia*: that it crost over all *Italy*, being nearly vertical to *Rimini* and *Savigniano* on the one Side, and to *Leghorn* on the other: that its perpendicular Altitude was at least 38 Miles: that in all Places near this Course. it was heard to make a hissing Noise as it passed; *Ronzarè, Far strepito comme un fuoco artificiale, Fisciare per aria comme un Raggio di polve*; that having past over *Leghorn* it went off to Sea towards *Corfica*, and lastly that at *Leghorn* it was heard to give a very great Blow, *Tuono di maggior rumore di grossa Cannonata*; immediately after which another sort of Sound was heard like the rattling of a great Cart running over Stones, which continued about the time of a *Credo*.

He concludes from the apparent Velocity it went on with at *Bononia*, at above 50 Miles Distance, that it could not be less swift than 160 Miles in a Minute of Time, which is above Ten times as swift as the diurnal Rotation of the Earth under the Equinoctial, and not many times less than that wherewith the annual Motion of the Earth about the Sun is performed. To this he adds the Magnitude thereof, which appeared at *Bononia* bigger than the Moon in one Diameter, and above half as big again in the other; which with the given Distance of the Eye, makes its real lesser Diameter above half a Mile, and the other in proportion. This supposed, it cannot be wondred that so great a Body moving with such an incredible Velocity through the Air, though so much rarified as it is in its upper Regions, should occasion so great a hissing Noise, as to be heard at such a Distance as it seems this was. But 'twill be much harder to conceive, how such an *impetus* could be impressed on the Body thereof, which by many Degrees exceeds that of any Cannon Ball; and how

this *impetus* shou'd be determined in a Direction so nearly parallel to the Horizon; and what sort of Substance it must be, that could be so impelled and ignited at the same time: there being no *Vulcano* or other *Spiraculum* of subterraneous Fire in the *N. E.* parts of the World, that we ever yet heard of, from whence it might be projected.

I have much considered this Appearance, and think it one of the hardest things to account for, that I have yet met with in the *Phænomena* of *Meteors*, and am induced to think that it must be some Collection of Matter form'd in the *Æther*, as it were by some fortuitous Concourse of Atoms, and that the Earth met with it as it past along in its Orb, then but newly formed, and before it had conceived any great *Impetus* of Descent towards the Sun. For the Direction of it was exactly opposite to that of the Earth, which made an Angle with the Meridian at that time (the Sun being in about 11 Degrees of *Aries*) of 67 Gr. that is, its Course was from *W. S. W.* to *E. N. E.* wherefore the *Meteor* seem'd to move the contrary Way: And besides falling into the Power of the Earth's Gravity, and losing its Motion from the Opposition of the *Medium*, it seems that it descended towards the Earth, and was extinguish'd in the *Tyrrhene Sea*, to the *W. S. W.* of *Leghorn*. The great Blow being heard upon its first Immersion into the Water, and the rattling like the driving a Cart over Stones being what succeeded upon its quenching; something like which is always observed upon quenching a very hot Iron in Water. These Facts being past dispute, I would be glad to have the Opinion of the Learned thereon, and what Objection can be reasonably made against the abovesaid *Hypothesis*, which I humbly submit to their Censure.

P. S. Since this was written, there has fallen into my Hands an Account of much such another Appearance, seen in *Germany*, in the Year 1686, at *Leipsic*, by the late Mr. *Gottfried Kirch*, who was for many years a very diligent Observer of the Heavens'

Heavens, and perfectly well instructed in Astronomical Matters. He in an Appendix to his *Ephemerides* for the Year 1688, gives us this remarkable Relation in the following Words.

Die 9 Jul. Æ. vct. Hora 1 ½ matutina, Globus ardens cauda peditus in 8 ½ Gr. Aquarii & 4 Gr. Sept. apparuit, qui per semiquadrantem Hora immotus perstitit, cujus diameter semidiametrum Lune circiter æquabat. Primo lux tanta erat, ut ejus ope sine candelis legere potuissimus: postea pedetentim in loco suo evanescebat. Phenomenon istud dicto tempore multis aliis in locis pariter visum est, præsertim Schlaizii, oppido undecim milliaribus Germanicis abhinc (i. e. a Lipsiâ) versus Meridiem distante, altitudine circiter 60 Gr. ab Horizonte meridiano.

At the time of this Appearance the Sun was in $26 \frac{1}{2}$ Gr. of \S , and by the given Place of the Meteor, 'tis plain, it was seen about $\frac{2}{3}$ of an Hour past the Meridian, or in S. by W. and by its Declination it could not be above 24 Degrees high at *Leipsic*, though the same, at *Schlaize* was about 60 Gr. high: The Angle therefore at the Meteor was about 36 Gr. Whence by an easy *calculus* it will be found, that the same was not less than 16 German Miles distant in a right Line from *Leipsick*, and above $6 \frac{1}{2}$ such Miles perpendicular above the Horizon, that is at least 30 English Miles high in the Air. And though the Observer says of it, *immotus perstitit per semiquadrantem horæ*; 'tis not to be understood that it kept its Place like a Fixt Star, all the time of its Appearance; but that it had no very remarkable progressive Motion. For himself has at the End of the said *Ephemerides* given a Figure of it, which he has marked *Fig. D.* whereby it appears that it darted downwards obliquely to the Right Hand, and where it ended, left two Globules or Nodes, not visible but by an Optick Tube.

The same Mr. *Gottfried Kirch* in the beginning of a German Treatise of his, concerning the great Comet which appeared in the Year 1680, intituled *Neue Pinnels-Zeitung*,

printed at *Nurenburg* anno 1681, (of which perhaps we shall have further occasion to make mention) gives us a Relation of such another luminous Meteor seen likewise at *Leipsick* on the 22^d of *May* 1680. *ft. vet.* about three in the Morning: which though himself saw not, was yet there observ'd by divers Persons who made various Reports of it, but the more intelligent agreed that it was seen descending in the North, and left behind it a long white Streak where it had past. At the same time at *Haarburgh* the like Appearance was seen in *N.E.* or rather *N.N.E.*; as also at *Hamburg, Lubeck* and *Stralsund*, all which are about 40 *German Miles* from *Leipsick*: but in all these Places, by Persons unacquainted with the manner of properly describing things of this kind. So that all we can conclude from it is, that this Meteor was exceeding high above the Earth, as well as the former.

All the Circumstances of these *Phænomena* agree with what was seen in *England* in 1708, but it commonly so happens that these contingent Appearances escape the Eyes of those that are best qualified to give a good Account of them. 'Tis plain however that this sort of luminous Vapour is not exceedingly seldom thus collected; and when the like shall again happen, the Curious are entreated to take more Notice of them than has been hitherto done, that we may be enabled thereby better to account for the surprizing Appearances of this sort of *Meteor*.